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PRODUCTION OF LAMINATE COMPOSITE MATERIAL BY ROLL BONDING PROCEDURES

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This invention is concerned with a production of composite laminate stock, that is, a laminate structure having within the body discontinuities of which the surface portions which are prevented from welding together and having other portions at which welding is accomplished.

An object of the invention is the provision of such a laminate stock at which the non-welding regions are closely controlled as to their widths and lengths, and their spacings from the edges of the stock and from one another.

Another object is the making of such a stock under conditions to prevent shifting and lateral spreading of an included anti-welding material during the course of operations.

Another object is the provision of a billet including enclosed discontinuities containing weld-preventing or resist material of high density and regularity.

A further object is the provision of a laminate stock of multiple layers including cladding material presented adjacent the anti-welding material so that upon opening of the stock into a tubular form the hollow space of a tubing is protected by cladding material.

A further object is the provision of stock layers having surfaces cooperating to provide welded areas and to provide channels for anti-welding material.

A further object is the provision of initial layers having coatings thereon for facilitating welding at desired areas.

A further object is the provision of initial layers for incorporation into a laminate stock, these layers having portions with coatings which facilitate the later operations of reduction to a desired dimension of thickness.

With these and other objects as features in mind, illustrative practices of the invention are shown on the accompanying drawings in which:

FIGURE 1 is a perspective view of portions of initial layers of material which are to be joined for forming a laminate stock.

FIGURE 2 is a corresponding view showing another form of initial layers.

FIGURE 3 is a corresponding view, showing another form of practice.

FIGURE 4 is a fragmentary cross-section on an enlarged scale, showing the laminate stock after assembly welding.

FIGURE 5 is a view corresponding to FIGURE 1, showing the provision of a cladding material as a thin coating.

FIGURE 6 is a view corresponding to FIGURE 2, and illustrating a second form of providing cladding material.

FIGURE 7 is a perspective view of the laminate stock after welding.

FIGURE 8 is a perspective view showing an end seal applied.

FIGURE 9 is a perspective view of a trimmed portion of a laminate stock after rolling to final thickness.

FIGURE 10 is a perspective view of a tube formed from the stock of FIGURE 9.

It is known to make a composite laminate stock by coating defined areas of a metal sheet with an anti-welding substance, for example, by printing such areas

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with an ink containing an anti-welding powder and a fluid binder; then to place a second sheet upon the first, and pass the assembly through rolls for effecting welding at the non-coated areas. It is likewise known to provide a billet with internal channels filled with anti-welding powder either by casting metal as an ingot around cores made of the powder in bonded form, or by drilling holes in a billet and filling these holes with the powdery anti-welding material. Such assembled plates or billets are then further rolled to attain a desired final thickness, wherewith the anti-welding material prevents welding over the areas or regions occupied by it, and itself yields in proportion to the yielding of the body metal.

With these known procedures, however, any displacement of the anti-welding material from intended position results in inaccuracy of the edges of the bonded areas, so that when the laminate stock is opened out to form a tubing, the internal hollows are not rectilinear. In addition, the migrating anti-weld powder may pass into areas where welding is necessary for strength, and thus produce a weak tubing.

According to the present invention, these difficulties are obviated by providing defined areas for reception of the anti-welding material, and thereby assuring accuracy in its location, both during the initial welding and during the later rolling to final thickness. Thereby it is feasible to effect a joining of the layers for closely controlled predetermined areas of definite location and width, with intervals between the bonding areas which likewise are of definite location and width.

As shown in FIGURE 1, a bottom slab 10 is made with one or more longitudinal grooves or channels 11 separated by intervening ribs or lands 12 and having marginal ribs or lands 13. Such slabs can be prepared directly by extrusion, e.g. if made of aluminum; by hot rolling, e.g. if made of steel or like material; by machining; or by other methods appropriate to the material which is to form the major portion of the body structure. The depth of the channels is determined by the thickness of anti-welding material which is to be present initially and must be effective during the later reduction to the predetermined final thickness. Preferably the channels are about 0.010 inch deeper than the intended thickness of the cores of anti-welding material. In FIGURE 1, these lands 12, 13 are flat on top, so that they abut over their areas with the top slab 14. The slabs 10, 14 can be 1½ inches thick at the channels 11; and may have desired cross-sections, a generally rectangular form being illustrated. It is preferred to provide for the escape of the air which occupies space between the powder particles, during heating and rolling: e.g. the welding of the end plates 16 need not be complete, or vent holes 19 may be provided in one or both plates, noting that the escape should be permitted at the end of the ingot which last passes the reducing rolls. The slabs 10, 14 are shown as of the same width: when brought flatwise together, their edges can be temporarily joined by torch or arc welding, e.g. as shown by the seam 15 to prevent later relative displacement. The channels 11 can then be filled with anti-welding powder; noting that one end can be sealed by crimping or by welding an end closure plate 16 (FIG. 8) in position, whereby to prevent excessive leakage at one end while filling is being accomplished at the other end, with such other end then being closed in like fashion. The end which enters the roller rig is preferably sealed; while the trailing end may have vents for the escape of air. This assembly is then heated and hot-rolled, with a first reduction preferably being over 30 percent in thickness, so that the lands of slab 10 are welded over their entire top areas to the slab